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الجامعة التقنية الشمالية
قسم هندسة تقنيات البيئة والتلوث

حقيبة تدريبية

بعنوان: تقيم الاثر البيئي Environmental Impact Assessment

إعداد
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فهرس المحتويات

Teaching Schedule

Week	Topic
1	Introduction to the course, What is EIA? Definition and history of environmental impact assessment
2-3	Tools for assess environmental impact: Checklist, Network, Matrices, Overlays, Mathematical Modeling.
4-5	Environmental Impact Assessment for air and noise
6-7	Environmental Impact Assessment for soil and land use
8-9	Environmental Impact Assessment for water quantity and quality
10-12	Environmental Impact Assessment for biological: terrestrial ecology forest and wildlife
13-15	Environmental Impact Assessment for biological aquatic ecology: plankton, nekton, benthos and importance coastal habitat

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الاسبوع الاول
(الوحدة النمطية)

Introduction to the course, What is EIA? Definition and history of environmental impact assessment

What is Environmental Assessment ?

- Definition
  - *EA is a systematic process to identify, predict and evaluate the environmental effects of proposed actions.*
  - Applied prior to major decisions and commitments
  - EIA and SEA are both forms of EA but are applied at different levels
    - SEA – applied at the policy and plan making level
    - EIA – applied at the project level
- A planning tool providing an aid to decision-makers, policy makers, developers, industrialists and the public. It does not provide the answers - only a vehicle to get to the answers in a logical and ordered manner
- Why are SEA & EIA important?
  - Environmental effects of major Policies, plans & projects

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- Increased globalisation of economies has lead to global effects
- Sustainability policy making identified EA as a significant tool to apply to arrest environmental degradation

Need for SEA & EIA:-

- To identify and evaluate all potentially significant environmental effects of proposed undertakings, at a stage when alternative solutions, including remedial measures and the alternative of not proceeding, are available to decision makers.
- To ensure that the proponent and governments and agencies required to approve the undertaking give due consideration to the means of avoiding or mitigating and adverse effects prior to granting approval.

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الاسبوع الثالث والرابع

الوحدة النمطية

Tools for assess environmental impact: Checklist, Network, Matrices, Overlays, Mathematical Modeling

Environmental Impacts

- Type
  - ecology
  - water quality
  - social
- Nature
  - direct
  - indirect
  - cumulative
- Magnitude & severity
  - high, moderate, low
- Extent
  - local
  - regional

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- transboundary

- <u>Timing</u>
    - immediate / long term

<u>Development of EA</u>

<u>EIA</u>

- USA National Environmental Policy Act 1969
- 1970s - Australia, Canada, Columbia
- 1980s - European Union & development on secondary systems
- 1990s - World Bank, development institutions

<u>SEA</u>

- 1980s - initial steps into SEA
- 1990s – SEA institute by a number of countries
- 2000 – SEA widely adopted & progress toward sustainability assessment
- <u>Why EA Process?</u>
    - Does not consist of linear step by step activities

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- EA is iterative - includes feedback loops to continually improve plan or project and understand the implications for the environment
- Represents a method of refining a proposal, informing decision making and addressing the environmental effects

- Impact Analysis
  - Identify and predict likely environmental effects of project
  - Evaluate these impacts
    - Are they significant?
    - Can they be prevented, reduced or offset?
- Mitigation
  - Identify ways that significant impacts can be prevented, reduced or offset
- Environmental Statement
  - Presentation of the results of the EIA process until this point

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Environmental Impact Assessment for air and noise

Assessment of Significance

Finally Determined Impact Significance:

Impact Severity	Impact Likelihood (A) Never Heard of in Oil & Gas Industry (Extremely Unlikely)	(B) Heard of in Oil & Gas Industry (Unlikely)	(C) Incident has Occurred in Region (Low Likelihood)	(D) Happens Several Times per Year in Region (Medium Likelihood)	(E) Occurs Several Times per Year at Site (High Likelihood)
Slight	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact
Low	Negligible Impact	Negligible Impact	Negligible Impact	Negligible to Minor Impact	Minor Impact
Medium	Negligible Impact	Negligible Impact	Minor Impact	Minor - Moderate Impact	Moderate Impact
High	Negligible to Minor Impact	Minor Impact	Moderate Impact	Major Impact	Major/ Critical Impact

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Noise Assessment

- Noise is;
  - unwanted sound
  - decibels (dB)
  - sound pressure level
- The human ear is more responsive to mid frequencies than high or low frequencies
- A weighting mechanism dB_A is used to mimic the human ear
- Noise is a logarithmic scale so an increase of 10 dB doubles the sound pressure level
- Terminology
  - **L_{Amax} –** The maximum A-weighted sound pressure level recorded over the measurement period.
  - **L_{Aeq} –** The equivalent continuous A-weighted sound pressure level (an average of sorts).
  - **L_{A10}** – The sound pressure level that is exceeded for 10% of the time.
  - **L_{A90}** – The sound pressure level that is exceeded for 90% of the time (the background noise level).

Noise Assessment Baseline Environment

- Establish Ambient Noise
  - Monitor noise at communities in vicinity of project activities

Location	L_{eq24hr}	L_{max}	L_{90}
Infield Facilities	46.1 - 64.2	82.9 - 92.3	38.2 – 64.3
Pipeline	41.7 - 64.9	74.8 – 105.9	38.2 – 67.5
GPP	46.4 – 61.6	74.8 – 105.9	42.2 – 48.1
Ambient Noise Standard	**70**	**115**	

Source: KKU and STS Green (2003)

<u>Noise Assessment Impact Assessment</u>

<u>Identify sources of Impact</u>

- Construction
  - Vehicles, such as;
    - Bulldozers, Excavators & Trucks
  - Equipment, such as;
    - Generators, Auger boring machine, UBD rig
- **Operation**

<u>Identify Potential Effects</u>

- Construction & Operation
  - Annoyance & disturbance at sensitive receptors

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Evaluate Impacts

- Predict noise levels
  - Engineering Equipment & Materials Users Association, Specification 140 Noise Procedure
- Compare to Ambient Noise Standards
  - L_{eq24hr} = 70dB(A)
  - L_{max} = 115dB (A)
  - L_{90} = an increase of more than 10dB (A) from ambient noise conditions is recognised as disturbance

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Impacts predicted for construction of GPP Plant

Sensitive Receptors	*Predicted SPL (dBA) during construction*	*Baseline L_{90} (Average)*	*Level of Annoyance (dBA)*
Normal Construction (PWL 125 dBA)			
Ban Kham Yai (~0.8 km WSW)	50	47-50*	0 - 3 (Not Annoying)
Wat Ban Kham Yai (~0.87 km W)	49	48	1 (Not Annoying)
Ban Kham Yai School (~0.88 km SW)	49	46	3 (Not Annoying)
Auger Piling (PWL 114 dBA)			
Ban Kham Yai (~0.8 km WSW)	39	47-50*	< 0 (Not Annoying)
Wat Ban Kham Yai (~0.87 km W)	38	48	< 0 (Not Annoying)
Ban Kham Yai School (~0.88 km SW)	38	46	< 0 (Not Annoying)

Note: * Baseline data not available - therefore assumed/anticipated for such an area.

Source: ERM (2004)

Identify Mitigation

- Use good site practice, such as;
  - Select quiet plant
  - Select quiet working methods
  - Well maintained plant
  - Shut down plant between work periods
  - Orientate plant to direct noise away from sensitive receptors

- Use silencers or mufflers

- **<u>Assess Impact Significance</u>**

Impact Type	Construction activities and equipment operation									
Impact Magnitude	Ambient Noise & Nuisance Standards at Sensitive Receptors									
Impact Nature		Negative		Neutral		Positive				
Impact Category		Direct		Secondary		Indirect		Cumulative		
Impact Extent		Local		Regional		Global				
Impact Duration		Temporary		Short-term		Long-term		Permanent		
Impact Severity		Slight		Low		Medium		High		Critical
Likelihood	(E) Continuous during active construction (day-time)									
Significance		Negligible		Minor		Moderate		Major		Critical

- **<u>Improvements</u>**
  - Additional information on prediction method
    - Summary of procedure
    - Indication of standing of standard, i.e. international, national, local
  - Predict significance before mitigation
    - Highlight effectiveness of mitigation
    - Provide a worst case scenario

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Environmental Impact Assessment for soil and land use

Land degradation is related to climate and soil characteristics, but mainly to deforestation and inappropriate use and management of the natural resources soil and water. It leads both to a non sustainable agricultural production and to increased risks of catastrophic flooding, sedimentation, landslides, etc, and effects on global climatic changes pacts. Landslides in hillslopes, which have been generally viewed as isolated catastrophic events resulting from infrequent rainfall and seismic events, are becoming major erosion and sediment transport processes worldwide, where deforestation (Sidle, 1992) and drastic land use changes occurs, causing irreversible land degradation. Even in cases where landsliding is related only to extreme rainfall events with long return periods, the amount of soil removed and off-site effects generally outweigh the effects of the more studied continuous surface erosion processes. The influence of the effects of land use and management changes, including the injudicious application of soil and water conservation practices

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and structures, like terracing, in triggering landslides and mass erosion in general, is largely overlooked.

Causes of land degradation Economic and social problems, connected to population pressure, market changes and prices, and technical needs, may produce drastic and sudden changes in land use and management, which may increase the potential hazard of land degradation and side effects (Pla, 1993). In some countries or regions of the World, agricultural production patterns and practices have changed over the last century, becoming highly mechanized, capitalized and specia lized, emphasizing labor-substituting technologies, which focus on the generation of short -term cash flow. In the absence of sufficient economic incentives for conservation, this type of agriculture incorporates no concern for long-term sustainability of production. In others, population growth and lack of resources have obliged to intensify the use of marginal lands without appropriate conservation practices, which is leading to land degradation and non sustainable agricultural production.

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Global climate changes may contribute to accelerate some land degradation processes and their effects in some regions of the World, but in any case, land use changes, including deforestation and other human activities leading to soil degradation processes may affect more the processes and effects of land degradation than the previewed global climatic changes, or may increase the influence of these changes (Pla, 2000). Moreover, appropriate land use and management can substantially reduce the buildup of atmospheric greenhouse gases and the derived global warming, reducing CO_2, N_2O and CH_4 emission and increasing carbon sequestration in vegetation and soil. Although land degradation risk may be mitigated by specific soil and crop management practices, some degree of production risk will always remain. In advanced agricultural systems land degradation processes are generally compensated by constant external inputs of energy, nutrients and other control measures, to avoid soil and water degradation effects. Any break in these artificial measures may cause a complete loss of productivity, as it frequently happens in developing countries due to economic setbacks. The negative effects of land degradation may be masked by technological inputs like improved crop varieties, heavy use of fertilizers, better pest and disease control, irrigation and improved tillage and planting methods, but there is

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eventually a point at which those inputs can no longer sustain economic production.

<u>All major developments</u> have the potential to cause significant environmental impacts as a result of disturbance to soil and land resources during both construction and operational stages. These may be associated with high financial costs to the proponent and the community, in addition to environmental degradation and loss of amenity. It is essential that such impacts be properly recognised, evaluated and addressed during the planning and feasibility stage of any development project. The purpose of this report is to provide a guide to requirements and methodology relating to the assessment of soil and landscape issues during the Environmental Impact Assessment (EIA) process.

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More specifically, it outlines:

� a broad overview of the EIA process and legislative responsibilities in NSW (Part 1);

� the normal soil-landscape data requirements and site survey methodology required for the project site (Part 2);

� guidelines on the evaluation of potential soil and landscape impacts (Part 3);

� overview of the types of measures needed to mitigate against the potential soil and landscape impacts (Part 4); and

� the major soil and landscape issues that normally apply to specific development types including

(i) urban development;
(ii) effluent disposing industries;
(iii) forestry operations;
(iv) mining and extractive industries;
(v) coastal-estuarine-riparian works; and
(vi) intensive agriculture (Part 5).

The report is principally concerned with land degradation impacts such as soil erosion and sedimentation, but also gives information on other land-

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related impacts such as mass movement impacts (eg, slope failure), pollution impacts (eg, soil and water contamination) and hydrological impacts (eg, flooding). It does not deal with other environmental impacts such as loss of biodiversity. This report is designed to guide in the assessment of soil and landscape issues rather than provide a comprehensive and universal checklist of requirements for all situations. Not all of the issues addressed in the document will be applicable to each project. Conversely, there may be additional issues not covered here. Although this guide is mainly designed to assist proponents during the preparation of Environmental Impact Statements (EISs) in NSW under Parts IV and V of the Environmental Planning and Assessment Act 1979, it is also applicable to other environmental assessment and planning processes. These include the preparation of Statements of Environment Effects (SEEs) for less significant projects, project feasibility studies, and detailed management plans and designs (usually prepared for projects following approval). It is primarily the level of detail required for the different types of studies that will vary. The report is essential for all development proponents. It will form the basis from which the adequacy of an EIA will be judged with respect to soil and landscape issues by the relevant

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Overview of Soil and Landscape Impacts soils are defined as the unconsolidated materials occurring at the land surface overlying the solid bedrock. They are typically composed of combinations of clay, silt, sand, gravel and organic matter, together with living organisms, water and air. These are normally present in the form of horizontal layers or horizons, forming a soil profile. Unconsolidated alluvial or windblown deposits such as sand dunes are also included in this definition. Soil is an extremely important resource, providing not only the medium for most plant growth and agricultural activity, but also the foundations for our infrastructure, filter systems for our effluent, and water barriers for our dams. Their relative thinness, scarcity and essentially non-renewable nature in Australia make them particularly valuable in this country. It is also a very fragile resource, being highly susceptible to loss and degradation when not properly managed or used within its capability. The term landscape as used here, refers to the broader physical character and conditions that make up a particular site. It takes in such factors as slope, topographic position, geology, water run-on and drainage characteristics, position in the wider catchment, and the nature of ground cover of the site. These factors can have a great bearing on the

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types of limitations that affect a site for particular developments. For example, the potential for soil erosion, flooding, mass movement and poor drainage are all affected by the position of a site in the landscape. It is generally a combination of soil and landscape properties as well as climatic factors acting in conjunction with each other that will determine the behaviour and potential problems of a particular site under a given activity. It is this principle that forms the basis of soil landscape mapping which is now being widely undertaken throughout NSW. Several adverse environmental consequences can occur due to inadequate assessment and management of potential soil and landscape impacts at a development site. The most widespread of these impacts is soil erosion and the associated transport of sediment to downslope sites, streams and waterbodies. For example, it has been estimated that 14 billion tonnes of topsoil is lost throughout Australia every year through erosion (Commonwealth Environment Protection Authority 1996). In 1988, it was estimated that more than 35% of NSW was affected by some form of water erosion (Soil Conservation Service of NSW 1990).

Other potential adverse impacts that may cause serious environmental degradation and damage to infrastructure include:

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� mass movement such as landslides and earth slumps;

� contamination of soils and waters through such activities as effluent disposal and application of farm chemicals;

� soil degradation through such processes as nutrient decline, compaction and salinisation;

� hydrological impacts such as flooding and waterlogging; and

� impacts from the disturbance of acid sulfate soils. The principles of ecologically sustainable development (ESD) need to be borne in mind. Soil and landscape resources need to be protected for future generations, not just for the life of proposed project. It is necessary to consider future use of the site. For example, the contamination of a soil by effluent may be acceptable for the life of a proposed industry, but may prevent any alternative future usage of that site. Another example is the loss of soil from an agricultural operation which may appear to be acceptable in terms of the life of the current landholder but may not be sustainable in the longer term, thus affecting future generations. It is also necessary to consider the issue of cumulative impacts in relation to a proposed project, ie, considering potential impacts in conjunction with the impacts from surrounding developments and land uses or those in the same catchment. For example, potential

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sedimentation of a waterway from a single development may appear to be insignificant, but when it is combined with the sedimentation derived from all surrounding developments, may be unacceptably high. The cumulative impacts from different phases of a development project, ie, construction, operation and post operation phases, also have to be considered.

Overview of EIA Process in NSW

b) Preliminary Design of Project

c)) Appropriate Site Selection

d) Scoping Exercise

e) Site Survey and Data Collection

f) Evaluation of Impacts

g) Design of Mitigating Measures and Monitoring Program

The design of measures to mitigate against the identified potential soil and landscape impacts and of a monitoring program to ensure the continued effectiveness of these measures is an important part of the EIA process. This matter is dealt with in Part 4. g) Preparation of the EIA Report Schedule 2 of the Environmental Planning and Assessment Regulations 1979 sets out items that must be addressed in an EIS report (see Appendix 2), in addition to

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specific requirements requested by the determining authority. Other forms of EIA reports would be expected to cover a similar range of items.

In relation to soil and landscape issues, the EIA report should include the following broad matters:

� Description of the soil and landscape at the site, including:

* summary of important features and limitations relating to soils (physical and chemical properties), landscape and climate

* map showing distribution of soil-landscape features (possible exception for small and uniform sites)

* detailed information such as specific field data, test results and methodologies used should be provided in Appendices

� Evaluation of impacts, including:

* the nature, magnitude and broader environmental significance of all potential significant impacts including how they are caused, what their effects will be, and methodologies used in the evaluation

� Outline of mitigating measures, rehabilitation and monitoring

* including an outline of appropriate management plans such as Erosion and Sediment Control Plans and Wastewater Management Plans.

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Legislative Responsibilities in NSW There is extensive legislation in NSW relating to the protection of soil and land resources of which development proponents must be aware. Farrier et al. (2000) provides a very useful account of the relevant legislation. This includes the: Environmental Planning and Assessment (EP&A) Act 1979 under which the State's planning and development processes are primarily controlled. It requires the preparation of environmental planning instruments such as Local Environment Plans (LEPs) and the undertaking of environmental impact assessments in the form of EISs or Statements of Environmental Effects (under Parts IV or V). The potential "environmental impacts on both the natural and built environments" must be considered by the consent authority when making approval decisions (s79C). The associated EP&A Regulations (Schedule 2) 1994 contain a list of factors that must be addressed by the proponent in an EIS. Several of these factors relate to soil and landscape issues (see Appendix 2). It is administered by Department of Urban Affairs and Planning. Note that revised Regulations are due for release in September 2000. Local Government Act 1993 that places responsibility on local government councils to properly "protect, restore, enhance and conserve the environment", which will have an indirect

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bearing on the development approvals process and on Councils' own operations.

It is administered by the Department of Local Government and the local Councils. Soil Conservation Act 1938 that provides for the "conservation of soil resources and for the mitigation of erosion". It provides for prosecution of developers and landholders where actions or failures to act are causing soil erosion or land degradation (s15A, 18 or 22). The Protected Lands provisions formerly in this Act are now within the Native Vegetation Conservation Act 1997. It is administered by DLWC. Catchment Management Act 1989, the objective of which is to bring about the coordinated and sustainable use and management of land, water, vegetation and other natural resources on a catchment basis. It relies on voluntary cooperation of the community, rather than a regulatory approach. It is administered by DLWC. Native Vegetation Conservation Act 1997 controls the clearing of native vegetation throughout NSW. Regional vegetation management plans are to be prepared to aid in this process. Soil and land degradation issues are considered as part of the planning and approval process under the Act. It is administered by DLWC. Crown Lands Act 1989.

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Any activities occurring on Crown Lands must be authorised under this Act, generally through a licence, lease or reserve. Activities must be in accordance with the Principles of Crown Land Management that stress the protection of soil, water and other environmental values (s11). It is administered by DLWC. Soil and Landscape Issues in EIA, DLWC Technical Report No. 34, 2000 7

Western Lands Act 1901 that provides for management and protection of all Crown Lands (comprising over 95% of total) in the Western Division of NSW. It requires an authority for clearing and cultivation of leasehold land. Lessees can be directed to undertake soil conservation measures, refrain from certain agricultural practices and preserve important vegetation. Rivers and Foreshores Improvement Act 1948 that provides for the protection and improvement of "protected waters" (ie, most rivers, lakes, lagoons and estuaries) and the associated "protected lands" (ie, beds, banks, shores and land within 40 m of these waters). A permit is required under this Act for any activity that may interfere with the flow of these "protected waters" or for any excavation or removal of material from "protected lands". It is administered by DLWC. Note that parts of this Act are being replaced by the Water Management Act 2000. Coastal Protection Act 1979 that provides for

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the protection, maintenance and restoration of the environment of the coastal region. Consent or concurrence under this Act is required where there is no existing environmental planning instrument or where a significant engineering or mining project is involved. It applies over the "coastal zone" which generally includes the beachfront, estuaries and adjoining wetlands, and offshore areas to the 3 nautical mile limit. It is administered by DLWC. Protection of the Environment Operations Act 1997, this replaces earlier pollution control legislation including the Clean Air Act 1961, Clean Waters Act 1970 and the Environmental Offences and Penalties Act 1989. The Act prohibits all activities that result in water or air pollution, except where they are carried out in accordance with a licence issued by the NSW Environment Protection Authority (EPA). It provides for the imposition of severe penalties for pollution offences. Such pollution includes sediment and dust, particularly where these are contaminated. It is administered by the EPA. Other Legislation. Various other legislation relating to specific land uses provide for the protection of soil and landscape resources including the Pesticides Act 1978, Environmentally Hazardous Chemicals Act 1985, Forestry Act 1916, Maritime Service, Mining Act 1992, National Parks and Wildlife Act 1974, Unhealthy Building Land Act 1990 and the Waste

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Minimisation and Management Act 1970. Relevant Government Policies. A number of NSW Government policies also provide for the protection of soil and landscape resources, bearing in mind the influence they have on the decision making process of NSW Government agencies. Important relevant policies include the:

� Total Catchment Management (TCM) Policy

� Native Vegetation Conservation Strategy (Draft)

� State Soils Policy

� NSW Coastal Policy 1997

� NSW State Rivers and Estuaries Policy.

EVALUATION OF POTENTIAL IMPACTS

This section outlines the major environmental impacts relating to soil and landscape issues that require consideration and analysis during the assessment and planning stages of a project. Details are provided on the broad methodology for predicting such impacts. The environmental impact assessment (EIA) must demonstrate that all potential impacts have been adequately analysed, including a determination of their magnitude and environmental significance. Quantitative analysis is preferred over qualitative

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analysis. Because soil erosion and associated sediment transport are generally the most widely encountered soil and landscape impacts on development sites, these have been given the most detailed treatment in this section. Other soil and landscape impacts including mass movement, soil contamination, soil degradation, hydrological impacts and disturbance to acid sulfate soils are covered in less detail because they are less frequently encountered and are better dealt with in other published guidelines.

Soil Erosion and Sediment

Transport Soil erosion and the consequent sediment transport are caused by the action of water, wind or gravity on exposed soil. The process involves the detachment of particles from the soil surface due to the force of raindrop impact, flowing water or wind and its subsequent transportation away from the site. The main categories of soil erosion are sheet, rill, gully, tunnel, streambank and wind erosion. It is possible for several of these to act simultaneously. These problems can be severe on many development and intensive land use sites where the vegetation has been cleared and the soil is entirely unprotected against erosional forces. Useful references include Rosewell et al. in Charman and Murphy (2000); and Clarke et al. (1985). (a)

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Major Impacts Soil erosion and sediment transport are associated with a range of serious adverse impacts on the environment, both from an ecological and human perspective. These impacts are located at the site of erosion, in the transporting waters and at the site of sediment deposition as discussed below.

i) Impacts at the site of erosion The most serious impacts are generally the loss of valuable soil, particularly topsoil, which provides the medium for plant growth. This soil loss results in less potential for agriculture, site rehabilitation, re-establishment of native ecosystems and development of landscaped gardens. Other impacts relate to damage to roads and building foundations, difficulties in many construction operations where bedrock has become exposed and the creation of access problems due to the presence of deep rills or gullies on site. Note that soil erosion can also occur on adjacent lands away from the development site as a result of increased water runoff. Soil and Landscape Issues in EIA, DLWC Technical Report No. 34, 2000 25

ii) Impacts in the transporting waters and air A serious impact is the reduction in water quality arising from high turbidity; sediment has been described as the world's greatest pollutant of surface waters. Contamination

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of the waters occurs when the eroded soil contains high nutrient levels (eg, from fertilisers) or hazardous chemicals (eg, from previous industrial activity). These problems result in degradation of the natural aquatic ecosystem (eg, replacement of native fish by exotic species such as carp); outbreak of blue-green algae, decline in quality of water for human use and loss of aesthetic and recreational values. In the case of wind erosion, fine dust can be carried hundreds of kilometres through the air, resulting in lowered air quality. Even relatively small quantities of airborne dust can lead to health problems for some people.

iii) Impacts at the site of sediment deposition The build-up of sediment in sites of deposition is often associated with serious problems. Waterways such as river channels, lakes, estuaries and wetlands may become filled with sediment leading to:

� a smothering of natural aquatic and riparian habitat, eg, sea grass beds or riverbank vegetation;

� increased streambank erosion and channel width, resulting in potential loss of riparian habitat and property;

� reduced waterway navigability;

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� increased flooding due to decreased carrying capacity of waterways; and/or

� damage and a loss in utility of public and private assets such as water storage facilities (includes small farm dams to major town reservoirs), harbours, stormwater channels, roads and causeways. The deposition of airborne dust can have significant impacts, particularly if large volumes are involved. Fine dust can cover or even partially bury various public or private assets such as roads, buildings and crops. Damage can occur to vehicles and machinery through dust intake. (b) Analysis of Impacts Determination of the potential extent of soil loss through erosion on a development site is essential to the prediction of the magnitude of the above-mentioned impacts and to the design of adequate control measures. For minor projects, a qualitative analysis may be sufficient, but for major projects where significant soil loss is likely, a quantitative analysis is generally required. Soil and Landscape

i) Qualitative estimation of soil loss The magnitude of soil loss is dependent on a number of factors as outlined below. soil erodibility - refers to the inherent susceptibility of the soil to erosion. It is dependent on a number of properties that may combine in complex relationships and is often difficult to accurately predict. Influencing properties include: texture - generally the finer

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the non-clay fraction, the more erodible the soil, eg, sand particles are less erodible than silt particles; high clay contents usually mean greater soil cohesion and less erodibility. structure - the greater the degree of soil particle aggregation, the more stable the soil. quantity of dispersible clay - dispersible clays are highly unstable in the presence of water and are easily eroded. Dispersibility is a result of high sodium contents. Conversely, clays which flocculate are more stable. permeability - low permeability results in high surface runoff leading to greater erosion. Coarser textured, well-structured soils with low sodium content are generally more permeable. organic content -soils with higher organic content are generally less susceptible to erosion. stone content - stones provide some protection against erosive impacts and generally serve to reduce erosion. slope factors - the slope gradient is a major determinant of surface water velocity (thus, erosive power) and water runoff compared to infiltration. Slope length (the length of uninterrupted slope surface) also influences surface water velocity. Thus, the greater the slope gradient and length, the greater the soil erosion potential. rainfall (and wind) erosivity - the intensity and duration of rainfall events determines the quantity and force of water impacting and flowing over the soil surface and causing erosion. In a similar way, the strength and duration of windy periods

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will influence the potential for wind erosion. ground cover - ground cover in the form of vegetation, mulch, stones or other materials serves to protect the soil from raindrop, water flow or wind impacts and also reduces the surface flow velocity of water or wind. Thus, the greater the extent of ground cover, the less is the erosion potential. land use and soil conservation practices - the extent to which good land management practices such as maintaining ground cover, contour ploughing and water management controls are implemented has a strong bearing on the erosion potential.

An analysis of the above factors as they apply to the project site will allow for a qualitative assessment of the magnitude of potential soil erosion and sedimentation impacts arising from the project. An examination of soil behaviour and the extent of soil landscape impacts occurring on other sites under comparable land use can also provide valuable guidance.

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الاسبوع الثامن والتاسع

(الوحدة النمطية)

Environmental Impact Assessment for water quantity and quality

WATER QUALITY IMPACT ASSESSMENT

Introduction

A water quality impact assessment has been undertaken to define the nature and scale of potential environmental impacts associated with the Project specifically in terms of the effects in the vicinity of sensitive receivers in accordance with the requirements of the Study Brief and Annexes 6 and 14 of the Technical Memorandum to the EIAO. Both construction and operational phase impacts have been assessed and mitigation measures have been identified to reduce any residual impacts to acceptable levels. 5.2 Legislation, Standards, Guidelines and Criteria Legislation, Standards, Guidelines and Criteria relevant to the consideration of water quality impacts under this study include the following:

• Water Pollution Control Ordinance;

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• Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems Inland and Coastal Waters;

• Environmental Impact Assessment Ordinance (Cap. 499) and Technical Memorandum on Environmental Impact Assessment Process;

• Technical Memorandum for Effluent Discharges. Apart from the above statutory requirements, the Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94), issued by ProPECC in 1994, also provide useful guidelines on the management of construction site drainage and prevention of water pollution associated with construction activities and are referred to in this report. Water Pollution Control Ordinance The Water Pollution Control Ordinance (WPCO) is the legislation for the control of water pollution and water quality in Hong Kong. Under the WPCO, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The WQOs set limits for different parameters that should be achieved in order to maintain the water quality within the WCZs. The ultimate discharge point for the Outfall is to the Western Buffer Water Control Zone as shown on Figure 5.1. The WQOs are applicable as evaluation criteria for assessing compliance of any effects from the

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construction and operation of the Project. Technical Memorandum for Effluent Discharges All discharges during both the construction and the operational phases of the Project are required to comply with the Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM) issued under Section 21 of the WPCO. The TM defines discharge limits to different types of receiving waters. Under the TM, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs must comply with the pollutant concentration standards for particular discharge volumes. Any new discharges within a WCZ are subject to licence conditions and the TM acts as a guideline for setting discharge standards for the licence. Environmental Impact Assessment Ordinance and Technical Memorandum on Environmental Impact Assessment Process Under Section 16 of the EIAO, Environmental Protection Department (EPD) issued the Technical Memorandum on Environmental Impact Assessment Process (TMEIA) which specifies the assessment methods and criteria for environmental impact assessment. This ProPECC Note is generally applicable for control of site runoff and wastewater generated during the construction phase of the Project. Technical Memorandum (TM), “Standards for Effluent Discharge

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into Drainage and Sewerage Systems, Inland and Coastal Water The Technical Memorandum (TM), "Standards for Effluent Discharge into Drainage and Sewerage Systems, Inland and Coastal Waters", issued under Section 21 of the WPCO defines acceptable effluent discharge limits to different types of receiving waters. With regard to inland waters, there is no distinction between different zones and the beneficial use of the inland waters is the only factor governing the quality and quantity of the effluent that should be met. Under the TM, inland waters are classified into four groups. These are given below in Table 5.1.

Table 5.1 Different Groups of Inland Water Specified in the TM

Inland Water Grouping	Beneficial use
Group A	Abstraction for potable water supply
Group B	Irrigation
Group C	Pond fish culture
Group D	General amenity and secondary contact recreation

For this Project both Group A and Group D waters prevail, as the Project encroaches on the Water Gathering Grounds as well as inland waters which are within the Study Area. The WQOs which prevail are given in Table 5.2 and Table 5.3.

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Table 5.2 Standards for Effluents Discharged into Group A Inland Waters (All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Determinand / Flow rate (m^3/day)	≤ 10	> 10 and ≤ 100	> 100 and ≤ 500	> 50 and ≤ 1000	> 1000 and ≤ 2000
pH (pH units)	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Temperature (°C)	35	35	30	30	30
Colour (lovibond units) (25mm cell length)	1	1	1	1	1
Conductivity (μg/c, at 20°C)	1000	1000	1000	1000	1000
Suspended solids	10	10	5	5	5
Dissolved oxygen	≥ 4	≥ 4	≥ 4	≥ 4	≥ 4
BOD	10	10	5	5	5
COD	50	50	20	20	10
Oil & Grease	1	1	1	1	1
Boron	2	2	1	0.5	0.5
Barium	2	2	1	0.5	0.5
Iron	2	2	1	0.5	0.5
Arsenic	0.05	0.05	0.05	0.05	0.05
Total chromium	0.05	0.05	0.05	0.05	0.05
Mercury	0.001	0.001	0.001	0.001	0.001
Cadmium	0.001	0.001	0.001	0.001	0.001
Selenium	0.01	0.01	0.01	0.01	0.01
Copper	0.2	0.2	0.2	0.2	0.1
Lead	0.1	0.1	0.1	0.1	0.1
Manganese	0.5	0.5	0.5	0.5	0.5
Zinc	1	1	1	1	1
Other toxic metals individually	0.1	0.1	0.1	0.1	0.1
Total toxic metals	0.3	0.3	0.2	0.2	0.15
Cyanide	0.05	0.05	0.05	0.05	0.02
Phenols	0.1	0.1	0.1	0.1	0.1
Hydrogen sulphide	0.05	0.05	0.05	0.05	0.05
Sulphide	0.2	0.2	0.1	0.1	0.1
Fluoride	1	1	1	1	0.5
Sulphate	800	600	500	400	200
Chloride	800	500	500	200	200
Total reactive phosphorus	1	0.7	0.7	0.5	0.5
Ammonia nitrogen	1	1	1	1	0.5
Nitrate + nitrite nitrogen	15	15	15	10	10
E. coli (count/100ml)	< 1	< 1	< 1	< 1	< 1

Table 5.3 Standards for Effluents Discharged into Group D Inland Waters

Determinand / Flow rate (m^3/day)	≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000
pH (pH units)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	30	30	30	30	30	30	30	30
Colour (lovibond units) (25mm cell length)	1	1	1	1	1	1	1	1
Suspended solids	30	30	30	30	30	30	30	30
BOD	20	20	20	20	20	20	20	20
COD	80	80	80	80	80	80	80	80
Oil & Grease	10	10	10	10	10	10	10	10
Iron	10	8	7	5	4	2.7	2	1.3
Boron	5	4	3.5	2.5	2	1.5	1	0.7
Barium	5	4	3.5	2.5	2	1.5	1	0.7
Mercury	0.1	0.05	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.05	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.8	0.5	0.5	0.2	0.2
Total toxic metals	2	2	1.6	1.6	1	1	0.5	0.4
Cyanide	0.4	0.4	0.3	0.3	0.21	0.1	0.1	0.05
Phenols	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Sulphide	1	1	1	1	1	1	1	1
Sulphate	800	600	600	600	600	400	400	400
Chloride	1000	800	800	800	600	600	400	400
Fluoride	10	8	8	8	5	5	3	3
Total phosphorus	10	10	10	8	8	8	5	5
Ammonia nitrogen	20	20	20	20	20	20	20	10
Nitrate + nitrite nitrogen	50	50	50	30	30	30	30	20
Surfactants (total)	15	15	15	15	15	15	15	15
E. coli (count/100ml)	1000	1000	1000	1000	1000	1000	1000	1000

Water Quality Objectives (WQOs)

The Water Pollution Control Ordinance (WPCO) (Cap.358) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, the whole Hong Kong waters are divided into ten Water Control Zones (WCZs). Water Quality Objectives (WQOs) were established to protect the beneficial uses of water quality in WCZs.

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الاسبوع العاشر والثاني عشر
(الوحدة النمطية)

Environmental Impact Assessment for biological: terrestrial ecology forest and wildlife

Environmental Impact Assessment (EIA) may provide a mechanism for implementing sustainable development and ensuring wise use of natural resources. By providing analytical procedures for studying relationships between organisms and their environment, ecological science has an obvious role in EIA, but this has been under-exploited under the existing legislation. Ecological input to environmental statements (ESs) for proposed developments has been criticized for its lack of scientific rigour and its failure to predict and evaluate ecological impacts. This article explores some barriers to the adoption of 'best practice' which derive from ambiguities in the wording of the legislation, key omissions in legislative requirements and scientific limitations. Scope for removing some of these barriers is considered. The need for a more strategic approach to ecological impact assessment, the introduction of standard protocols for survey and evaluation and of formal requirements for monitoring of ecological impacts is identified.

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international debate on sustainable development and conservation of biodiversity has gathered speed, focusing on the need to ensure that 'the needs of the present' can be met 'without compromising the ability of future generations to meet their needs' through environmental degradation and depletion of natural resources (WCED 1987). As pressure grows to ensure that economic growth and development are compatible with conservation of world biodiversity, Environmental Impact Assessment (EIA) has been heralded as a potential mechanism for implementing principles of sustainability and 'wise use'.

Principle 17 of the Rio Declaration on Environment and Development endorses the universal application of EIA 'as a national instrument' (McNeely 1994) and there is a clear role for EIA in the implementation of national sustainable development strategies (NSDSs) (Sadler 1993). By providing analytical procedures for studying relationships between organisms and their environment, ecological science has an obvious role in EIA, but the evolution of a recognizable discipline of 'eco- logical impact assessment' has been slow. Because the need for ecological impact assessment arises from a

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political or socio-economic motivation, there has been a tendency for scientists to doubt whether it is an acceptable forum in which to 'rigorously apply the scientific method' (Beanlands & Duinker 1984). Eco- logical studies undertaken for EIA have been subject to considerable criticism (by other ecologists) since the United States' National Environmental Policy Act (NEPA) first created a formal requirement for environmental impact assessment of proposed devel- opment actions in 1969 (Beanlands & Duinker 1984; Spellerberg & Minshull 1992; Treweek et al. 1993; Thompson 1995). Many of the issues raised remain unresolved and, as a result, ecological assessments carried out under EIA and related legislation continue to be seriously flawed. In practice, rather than developing as the mainstay of EIA, ecological impact assessment has emerged as a sub discipline which is often under-resourced and sometimes ignored altogether. The legislation has resulted in procedural frameworks which draw on ecology too little and too late and which fail to encourage good practice. If EIA is to be developed as a tool of environmental management which can help to realize the goals of sustainability and biodiversity conservation, it is important that ecologists should have a much greater input, particularly in developing.

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its scientific basis. This article explores some of the possible reasons why ecology continues to be marginalized within the EIA process and why scientists continue to regard EIA as unworthy of their attention. There appear to be persistent barriers to the adoption of 'best practice', which need to be investigated. These may be of a legislative (political), scientific or technical nature. Requirements for ecological impact assessment derive primarily from legislative demand for EIA, which is outlined in the first part of the article. Possible ambiguities in the wording of the legislation and important omissions with respect to requirements for ecological input are then explored to interpret some of the observed shortcomings in ecological input to EIA. The role of scientific limi- tations to the evolution of predictive power in eco-logical impact assessment is then considered.

REQUIREMENTS FOR ECOLOGICAL INPUT TO EIA EIA is used to predict the environmental consequences of proposed human actions, whether these are individual projects (like the construction of a power station), groups of related projects or government policies. In most countries, EIA has been implemented through planning and other development consent procedures and its commonest application has been with respect to individual

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projects or single actions. However, there are many environmental effects which cannot be regulated effectively on such a restricted basis. There has been growing pressure in most countries of the world for EIA to be applied at higher tiers in the decision-making process, ensuring that the environmental implications of policies, plans, programs and 'families' of projects are taken into account as well as those of individual projects. Other- wise there is no mechanism for assessing the overall impacts of related projects (power stations and pipe- lines, for example), the cumulative impacts of serial developments (a number of power stations) or the relative merits of alternative sites, methods or processes (coal-fired power stations vs. wind farms).

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In Europe a draft Directive on strategic environmental assessment (SEA) has been circulated for consultation, but in the meantime, EIA remains applicable only at the project level, as required under the EA Directive (85/337/EEC). In the UK, the Directive has been implemented through specific sets of Regulations covering different categories of development. The most far-reaching in application are those relating to the town and country planning system in England and Wales (ST 1988; no. 1199), but there are many others (for example the Land Drainage Improvement Works (Assessment of Environmental Effects).

In accordance with the "polluter pays" principle, the EC Directive requires proponents of certain developments to undertake assessment of the likely environmental effects of their proposals and to submit the findings to the relevant competent authority in the form of an environmental statement (ES). In common with much EIA legislation worldwide, the Directive makes some stipulations concerning the content of the ES, but does not specify the methods by which the EIA itself is to be conducted. This 'product-driven' approach to EIA has been much criticised for its failure to address obvious methodological shortcomings (Smith 1993; Ortolano & Shepherd 1995). In

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fact it is possible that EIA may have done little to ensure that environmentally sound decisions are actually made, as the main output of the process, the ES, is often of questionable content and quality. While it is important that EIA methodology itself should be subject to critical appraisal in order to pro- mote 'best practice', review of ESs remains the most straightforward way to get an overview of ecological input to EIA. There are some difficulties in conducting reviews of ESs, however, as there is no centrally coordinated, comprehensive and up-to-date collection of ESs available in the UK. Some organizations and universities (notably Oxford Brookes and Manchester Universities) which have undertaken to maintain their own collections of ESs have found them often difficult to track down and expensive to buy. In practice, ESs are summary documents which present the results of a range of EIA-related studies and it is unusual for them to include full accounts of any ecological assessments which may have been carried out. There is a great deal of anecdotal evidence to suggest that the results of ecological assessments may be misinterpreted, materially altered, over-summarized or even ignored in ESs, so reviews of their ecological content must be treated with some caution. Never- the less, ESs are intended as stand-alone documents which provide all the information needed to

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evaluate the likely environmental implications of a proposal. At the very least, their content should be in compliance with the requirements of the Directive, but reviews of ESs suggest that many fail even to do this with respect to ecological considerations (Treweek et al. 1993; Thompson 1995; Morris 1995). Criticism of the ecological content of ESs has been voiced so often that to reinforce it further may seem superfluous, but it is important to emphasize quite how ecologically deficient the majority of ESs are. A selection of bald statistics may help: in a review of 37 ESs for proposed new roads, the area of land to be taken was only quantified in one and none gave detailed breakdowns of the areas of wildlife habitat which would be lost (Treweek et al. 1993). In the same study, only 35% of ESs included results of field surveys and of these, 31% (11% of the whole sample) had been carried out at inappropriate times of the year. There were no cases where surveys had been repeated to gain any indication of temporal trends. Such shortcomings are common across the full range of development type

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INTERPRETING THE LEGISLATION

Examination of the EC Directive as implemented in the UK reveals ambiguities in meaning which may be partly responsible. The need for an ecological approach to EIA is strongly implied, but not stated explicitly, and interpretations of legislative requirements for ecological input have varied as a result. In terms of EIA practice and actual requirements for ecological input, the legislation appears almost deliberately vague. The requirements of the Directive and the UK regulations are summarized in a Guide to the Procedures published by the Department of the Environment (DoE 1989). In summary, proponents are required to provide a description of the proposed development, the data necessary to identify and assess its main environmental effects, a description of the likely significant effects, a description of measures envisaged to avoid, reduce or remedy any significant adverse effects and a non-technical summary. Further information may be included to explain or amplify any of this information and some (limited) guidance is given as to what this might be. The 'Guide' also includes a checklist of 'matters to be considered for inclusion'. It is not my intention to

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provide a comprehensive account of the legislation, but simply to highlight some instances where ambiguities may have contributed to some observed shortcoming.

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الاسبوع الثالث والخامس عشر
(الوحدة النمطية)

Environmental Impact Assessment for biological aquatic ecology: plankton, nekton, benthos and importance coastal habitat

Sampling methodology

This Guideline does not provide detailed methods for sampling but a brief review, with references, is presented to provide an overview of some of the methods currently in use. Data obtained from field studies should provide an objective basis for the EIA process. Sampling methods should be repeatable and, in most cases, quantitative data should be obtained .Proponents selecting consultants to do field studies should expect them to be familiar with and preferably have a practical experience of, the methods required to sample the decision variables selected.

(a) Describing aquatic habitats

Describing aquatic habitats likely to be affected by a proposed project is fundamental to the EIA process. By knowing what habitats are present, it

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may be possible to infer the types of plants and animals that will also be present. Moreover, by knowing the extent of the habitats that may be affected, the impact can be placed within the local, regional and state contexts. Two approaches are used commonly:

a simple inventory of habitats

quantitative measures of extent and distribution

Whichever approach is used, it may be useful to obtain photographs of different habitats to provide a permanent record prior to development.

Habitat inventory

The simplest description normally made is to visit the site and compile an inventory of habitats present. Within an estuary, for example, there may be seagrasses, mud or sand banks, deep holes, mangroves, saltmarshes or rocky substrata (natural and artificial) (Burchmore et al. 1993). Within a river, habitat inventories should include the presence of aquatic macrophytes, deep holes, snags, adjacent wetlands and billabongs/anabranches. A limitation with this approach is that it fails to provide an objective indication of the size of various habitats, which could be used for assessing importance in a

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regional context, for assessing the potential impact or for measuring the extent of change. This limitation is of greater concern where habitats are fragmented within the landscape and where some measure of the extent of habitats and their relationships to one another is needed. A good example of this is on rocky reefs, where habitats often occur as a mosaic of patches (eg. kelp, turfing algae, rock barrens, etc) within the reef structure (Underwood et al. 1991). This example also raises the issue of the coarseness of habitat definition that may be appropriate. In some cases its may be sufficient to simply identify the presence of rocky reef. In others may be important to identify the range of reek habitats occurring within the rocky reef. This issue also arises in studying saltmarshes, where there a numerous species occurring with different distributions within this broad habitat type. Quantitative description of habitats Where scoping studies identify an aquatic habitat that is likely to be lost, reduced or otherwise modified by a proposed project, it is usually important to obtain a quantitative estimate of the size of the habitat present. This allows the magnitude of changes to be predicted and to place them in a local or regional context. Adopting this framework has the advantage of allowing habitat information to be layered within Geographic Information Systems (GISs) and can be used as a valuable tool in impact

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assessment by incorporation into "constraints mapping" (Morris and Therivel 1995; see also Part 4). Methods used to describe quantitatively habitats will depend upon the proposed project and the spatial scale of interest to the investigation. Four types of quantitative description are seen in EISs, including: habitat mapping from the ground using base maps or remote imagery (eg. aerial photographs and satellite imagery) defining the boundaries of habitats or features within habitats determining patch size of features within habitats or within a mosaic of habitats modelling the extent of habitats under different environmental conditions. Some EISs attempt to model quantitatively the extent to which habitats vary under different environmental condition, both natural and humaninduced. For one EIS, changes to beach habitat and intertidal rocky shores were modelled in relation to changes in wave energy (Metromix 1993). In another, changes to water depth, sedimentary processes and wetted perimeter of a river were modelled in relation to changing flow conditions (Dames & Moore 1996). Modelling changes in habitat due to natural variation can allow the assessment of the effects of the proposed project in relation to the natural background. This could be potentially limited by the need to calibrate such

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models with real data and then validate them by applying them to a real situation in nature.

Some habitats may be difficult to quantify, for example the habitat provided by snags within a river. It is possible to count the number of snags over set distances of river, but the irregular shapes and sizes of the snags are difficult to quantify. Depending on the question of interest and the nature of the waterway, it may either be possible to count snags or develop a measure that take into account categories of type and size of snags. NSW generally has a good coverage of aerial photos. These are often available for the same places at different times, sometimes spanning several decades. Aerial photos were used to map the distribution of seagrasses, mangroves and saltmarshes in estuaries and embayments along the NSW coast in the mid-1980's (West et al. 1985). Aerial photos can be digitised to provide very accurate mapping and determination of areas. Satellite imagery also has the potential for use in defining habitats, but has as yet rarely been seen in investigations of aquatic ecology in NSW. Key issues that should be considered in using remote images are: the need to define boundaries of habitats accurately the need for ground-truthing to verify the habitats. For example, rocky reefs, algal

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beds and seagrass beds may look similar in remote images and can all coexist within a small area. For some investigations, it may not be critical that the area of a certain habitat is known, but it may be important to define where the boundary of that habitat occurs in relation to a proposed project. Aerial photos may readily be used to define boundaries of some features. Where these are obscured in the image, or photos are unavailable, it may be possible to mark the edge of each boundary to determine its relationship to the proposed project, or to measure precisely changes in boundaries through time. At smaller spatial scales, it may be important to define patches of habitat or the extent to which habitats are fragmented. This may be important, for example, when assessing the effects on adjacent seagrasses from mooring chains and boat operations associated with a dredging operation. One method used frequently to quantify patch size and/or percentage cover is a line-intercept procedure. Typically, transects are laid within the area of interest and the type of cover is recorded at pre-determined points or intervals along the transect (eg. Morris and Therivel 1995). This method can be used on coral and rocky reefs, seagrass beds, mangroves, saltmarshes, etc. It is also used in rivers, where habitats can be described along or across the river.

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Forecasting

(a) The basis for predicting effects Predicting the response (if any) of a decision variable to a disturbance can be very difficult and, in the absence of firm scientific information, requires a precautionary approach. An EIS should explicitly define the basis of each predicted effect on aquatic ecosystems and obtain the following information in deriving each prediction:

a good understanding by aquatic ecologists of the nature of the proposed project, including project design, construction activities and timing;

detailed predictions of physical and chemical changes (often provided by other specialists) resulting from the proposed project;

a description of habitats and selected decision variables;

knowledge of how decision variables respond to the proposed disturbance;

knowledge of the outcomes of similar projects elsewhere; and

knowledge of past, existing or other approved projects nearby which may cause interactive or cumulative impacts with the project being assessed. In some cases, predictions are based on modelling or

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simulation of data. It is important to ensure that models are properly calibrated and independently validated with empirical data and that any assumptions are clearly identified. The EIS should identify the extent to which predictions of effects could be limited by failure to validate models. Finally, in the absence of a firm objective basis, predictions are often based on the professional opinion of the aquatic ecologist. Where this happens, the logic used to derive the prediction(s) should be described and the subjective basis of the prediction acknowledged.

(b) Frameworks for prediction of effects Predicting impacts for a proposed project should be done within a structured framework (eg. Morris and Therivel 1995, Thomas 1998). Some frameworks are discussed here, with examples, and it is clear that there is scope for considerable overlap among frameworks. Haug et al. (1984) also addressed this issue and attempted to define what “significant impacts” might be. Izmir (1993) examined ways in which environmental impacts could be valued. It is often relatively straightforward to identify and define physical and chemical effects, but more

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difficult to predict the consequences for aquatic ecology and how this may flow on to human activities.

(c) Direct and indirect effects Direct effects (also often called primary effects) can include the removal or creation of habitat, emplacement of barriers, etc. Indirect effects (also called secondary or tertiary effects) occur as a consequence of direct effects. An example of a direct effect would be the removal of seagrasses as part of a dredging project and the size of the effect can be quantified in terms of the area lost. An indirect effect might be the impact of the loss of seagrass on fish and crabs and the subsequent effect on local fishers. Quantifying indirect effects can be very difficult because it requires either knowledge or the need to make assumptions about the extent to which organisms may depend on the component of the ecosystem that is affected directly.

(d) Short and long-term effects Distinction is often made between different time periods of predicted effects on the aquatic environment. For example, a short term-effect associated with a dredging proposal might be the creation of a turbid plume while dredging is occurring, but a long term effect would be

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the alteration of substratum in the area dredged. In this case, both impacts are direct effects. In defining short and long term effects, it is also important to consider whether the consequences are short or long term (Glasby and Underwood 1996). For example, creation of a turbid plume might disrupt a significant settlement of aquatic organisms, which could have long term consequences for that population. Alternatively, whilst the dredging may alter habitat for years or decades, biological recolonisation may be rapid and have only short-term consequences on the productivity of the area. Thus, the duration and magnitude of physical effects may not be related directly to those of the ecological effects.

(e) Construction, operational and decommissioning effects. Many projects can be evaluated in terms of their construction and operational phases and distinctive impacts may be associated with each. Examples of these include construction of sewage outfalls, marinas and foreshore development.

(f) Intermittent, periodic and permanent effects Activities during both the construction and operational phases of a project can lead to intermittent, periodic or permanent effects, which are often similar to the short and long

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term effects discussed above. In the context of the construction phase, an intermittent effect would be runoff from cleared areas during rainfall; a periodic effect might be related to dredging done for certain periods each day and permanent effects may be associated with disposal of dredge spoil. In the context of the operational phase, an intermittent effect would include accidental spills (e.g. from fuel pumps on a jetty), periodic effects might be related to seasonal rainfall that leaches acids from acid sulfate soils while a permanent effect might include permanent loss of habitat due to reclamation.

(g) Opportunities and constraints Irrespective of the framework in which effects of a proposed project are assessed, it is often useful to identify concisely the opportunities and constraints (ie. predicted positive and negative impacts) associated with the project. Opportunities may include positive steps that could be taken to improve an area already disturbed by human activities (eg. removal of unwanted alien species); constraints may include the presence of endangered or threatened species, fishing grounds or habitat that should be preserved as part of the project design. (h) Isolated, interactive and cumulative effects The effects of a proposed project are often predicted in relation to other human development or activities within the

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waterway of interest and/or its catchment. Proposed projects are generally assessed in isolation of other projects, but there is an increasing requirement for interactive effects to be considered due to increasing pressure for development of waterways and the realisation that numerous small projects potentially can have large cumulative effects. A major difficulty associated with predicting cumulative effects is that there is often a lack of information on the effects of other projects.

Two suggestions that may be suitable for predicting cumulative effects are as follows:

Direct loss or creation of aquatic habitat. Cumulative effects can be predicted by estimating how much of a particular habitat has been lost or created in a waterway due to previous development, by predicting the potential change associated with the project being considered and examining predicted changes from other proposed projects. Estimates of earlier loss or creation may be made by reference to historical aerial photographs, bathymetry and earlier habitat maps (eg. West et al. 1985), etc.

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Introduction of nutrients, pathogens and toxic chemicals. Cumulative effects can be estimated by modelling the change in water quality indicators in relation to the existing background concentrations. Here it may be important to know the relative input from non-natural sources or it may simply be a case of estimating if the changed water quality indicators are within specified water quality guidelines.

Important and trivial effects Predictions regarding the effects of a proposed project should be evaluated in terms of their relative importance. Some impacts may be trivial whilst others are very important. The significance of predicted negative effects is often evaluated in terms of the magnitude of spatial scale and duration, the inertia, resilience and stability of the decision variables and the value of the ecosystem. Acceptable and unacceptable effects A final example presented is for effects on the aquatic environment that are predicted to be acceptable or unacceptable. By defining an effect as "acceptable" a proponent acknowledges that the proposed project would have an effect, but it is justifiable in terms of the benefits associated with the project. An "unacceptable" effect would obviously be a serious, if not fatal, impediment to a proposed project. Hopefully, this type of effect would be

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identified during the scoping phase of a project, in which case the proponent may decide that the project is not sustainable (and therefore not proceed) or seek to develop mitigative measures to minimise (ie. make acceptable) or remove that effect.

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